RTCA Special Committee 186, Working Group 3

ADS-B 1090 MOPS, Revision A

Meeting #4

ACTION ITEM 3-10

Appendix Material for 1090 TIS Broadcast

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SUMMARY
Formats for TIS-B on 1090 MHz have been reviewed at previous WG-3 meetings. This working paper proposes material for a new section of Appendix A on TIS-B based upon the approach agreed at the previous meetings. **As agreed during Meeting #4, during the presentation of this paper, this newly proposed text will become subparagraph A.2 with all previous Appendix A text in DO-260 becoming A.1.n.n.n.n**

1.0 Introduction

At the Phoenix meeting, the Working Group agreed to begin the documentation of TIS-B by assigning an action item to propose appendix material for this service. The intended approach was to add this material to Appendix A. However, on closer examination, it became evident that the TIS-B material should reside in its own appendix.

Because the fine TIS-B messages are closely related to the ADS-B messages, the TIS-B appendix will have numerous references to Appendix A. For this reason, it is desirable that the TIS-B appendix is physically close to Appendix A to make it easier to follow these references. To accomplish this purpose without renaming any existing appendices, it is proposed that the TIS-B appendix be labeled "A-1."

[During the presentation of this paper during Meeting #4, it was agreed that the approach would be to insert this proposed text into the existing Appendix A, but to renumber the DO-260 Appendix A text with a new subsection one (1) in front of all existing section numbers and to make this proposed TIS-B text begin with A.2. All references in DO-260 to any Appendix A subparagraphs would then be modified to insert a one (1) in front of all of the existing subparagraph section heading numbers.]

2.0 Proposed Initial Draft of Appendix A-1

A proposed initial draft for the TIS-B Appendix **A.2** is contained in the following pages.

A change is also required to paragraphs A.7.3 and A.7.5 to accommodate the 12-bit CPR encoding for TIS-B. A proposed change for these paragraphs is included in Working Paper 1090-WP-4-09.

[**In view of the agreement reached to number the new TIS-B text beginning with A.2, the above paragraph would be revised to read:]** A change is also required to paragraphs A.1.7.3 and A.1.7.5 to accommodate the 12-bit CPR encoding for TIS-B. A proposed change for these paragraphs is included in Working Paper 1090-WP-4-09.

Proposed Text for new section Appendix A.2

Traffic Information Service Broadcast (TIS-B)

Formats and Coding Definitions

A.2 Traffic Information Service – Broadcast (TIS-B) Formats and Coding

A.2.1 Introduction

Notes:

1. This section of Appendix A defines the formats and coding for a Traffic Information Service Broadcast (TIS-B) based on the same 112-bit 1090 MHz signal transmission that is used for ADS-B on 1090 MHz.

2. TIS-B complements the operation of ADS-B by providing ground-to-air broadcast of surveillance data on aircraft that are not equipped for 1090 MHz ADS-B. The basis for this ground surveillance data may be an ATC Mode S radar or a surface or approach multilateration system. The TIS-B ground-to-air transmissions use the same signal formats as 1090 MHz ADS-B *and can therefore be accepted by a 1090 MHz ADS-B receiver.*

3. TIS-B service is the means for providing a complete surveillance picture to 1090 MHz ADS-B users during a transition period. After transition, it also provides a means to cope with a user that has lost its 1090 MHz ADS-B capability.

A.2.2 TIS-B Format Definition

TIS-B information is broadcast using the 112-bit Mode S DF=18 format as shown below in Figure A-13:

Figure A-13: TIS-B Format Definition

A.2.3 Control Field Allocation

The content of the DF=18 transmission is defined by the value of the control field, as specified in Table A-21.

Table A-21: "CF" Field Code Definitions in DF=18 ADS-B and TIS-B Messages.

CF Value	"ATCRBS or Mode S" Flag	Meaning
0	N/A	ADS-B message from a non-transponder device, AA field holds 24-bit ICAO aircraft address
1	N/A	Reserved for ADS-B message in which the AA field holds anonymous address or ground vehicle address or fixed obstruction address
2	0	Fine TIS-B message, AA field contains the 24-bit ICAO aircraft address
	1	Fine TIS-B message, AA field contains the 12-bit Mode A code followed by a 12-bit track file number
3	0	Coarse TIS-B airborne position and velocity message, AA field contains the 24-bit ICAO aircraft address
	1	Coarse TIS-B airborne position and velocity message, AA field contains the 12-bit Mode A code followed by a 12-bit track file number.
4	N/A	Reserved for TIS-B management message AA field holds TIS-B service volume ID + other information (e.g., MSB of reference position for the service volume)
5 – 7	N/A	Reserved for other uses (e.g., for FIS-B messages)

A.2.4 TIS-B Surveillance Message Definition

A.2.4.1 TIS-B Fine Airborne Position Message

The TIS-B fine airborne position ME field shall be formatted as specified in Figure A-15.

Note: Additional details are specified in the following paragraphs.

A.2.4.1.1 ATCRBS/Mode S Flag (AMS)

This one-bit field (Bit #8) shall indicate the type of surveillance data reported in the TIS-B message. AMS equal to ZERO shall indicate that the TIS-B data pertains to a Mode S aircraft. AMS equal to ONE shall indicate that the TIS-B data pertains to an ATCRBS aircraft

Note: The AA field is coded differently for Mode S and ATCRBS aircraft as specified in Table A-21.

A.2.4.1.2 Pressure Altitude

This 12-bit field shall provide the aircraft pressure altitude. This field shall contain barometric altitude encoded in 25 or 100 foot increments (as indicated by the Q Bit).

A.2.4.1.3 CPR Format (F)

This field shall be set as specified in A.1.4.2.1

A.2.4.1.4 Latitude/Longitude

The latitude/longitude fields in the TIS-B fine airborne position message shall be set as specified in A.1.4.2.3.

A.2.4.2 TIS-B Surface Position Message

The TIS-B surface position ME field shall be formatted as specified in Figure A-15

Note: Additional details are specified in the following paragraphs.

A.2.4.2.1 Movement

This field shall be set as specified in A.1.4.3.1

A.2.4.2.1.1 Ground Track (true)

A.2.4.2.1.1.1 Ground Track Status

This field shall be set as specified in A.1.4.3.2.1.

A.2.4.2.1.1.2 Ground Track Angle

This field shall be set as specified in A.1.4.3.2.2.

A.2.4.2.1.2 ATCRBS/Mode S Flag (AMS)

This one-bit field (Bit #21) shall indicate the type of surveillance data reported in the TIS-B message. AMS equal to ZERO shall indicate that the TIS-B data pertains to a Mode S aircraft. AMS equal to ONE shall indicate that the TIS-B data pertains to an ATCRBS aircraft

*Note: The AA field is coded differently for Mode S and ATCRBS aircraft as specified in Tabl*e A-21.

A.2.4.2.1.3 Compact Position Reporting (CPR) Format (F)

This field shall be set as specified in A.1.4.3.3.

A.2.4.2.1.4 Latitude/Longitude

The latitude/longitude fields in the TIS-B fine surface position message shall be set as specified in A.1.4.3.5.

A.2.4.3 Identification and Category Message

The TIS-B identification and category ME field shall be formatted as specified in Figure A-17. It shall only be used for Mode S aircraft.

Note: Additional details are specified in the following paragraphs.

A.2.4.3.1 Aircraft Identification Coding

This field shall be set as specified in A.1.4.4.1.

A.2.4.4 Airborne Velocity Message

The TIS-B airborne velocity ME field shall be formatted as specified in the Figure A-17.

Note: Additional details are specified in the following paragraphs.

A.2.4.4.1 Subtype Field

Only subtypes 1 and 2 shall be used for the TIS-B airborne velocity message. Subtype 1 shall be used for velocities under 1000 knots and subtype 2 shall be used for aircraft capable of supersonic flight when the velocity might exceed 1022 knots.

The supersonic version of the velocity coding shall be used if either the east-west OR north-south velocities exceed 1022 kt. A switch to the normal velocity coding shall be made if both the east-west AND north-south velocities drop below 1000 kt.

A.2.4.4.2 ATCRBS/Mode S Flag (AMS) (Bit 9)

A.2.4.4.3 Magnetic Heading in Airborne Velocity Messages

A.2.4.4.3.1 Magnetic Heading Status

This field shall be set as specified in A.1.4.5.5.1

A.2.4.4.3.2 Magnetic Heading Value

This field shall be set as specified in A.1.5.5.1

A.2.4.5 Coarse Airborne Position Message

The TIS-B coarse airborne position ME field shall be formatted as specified in the Figure A-18.

Notes:

1. *This message is used if the surveillance source for TIS-B is not of high enough quality to justify the use of the fine formats. An example of such a source is a scanning beam Mode S interrogator.*

2. *Additional details are specified in the following paragraphs.*

A.2.4.5.1 ATCRBS/Mode S Flag (AMS)

This one-bit field (Bit #1) shall indicate the type of surveillance data reported in the TIS-B message. AMS equal to ZERO shall indicate that the TIS-B data pertains to a Mode S aircraft. AMS equal to ONE shall indicate that the TIS-B data pertains to an ATCRBS aircraft

Note: The AA field is coded differently for Mode S and ATCRBS aircraft as specified in Table A-21.

A.2.4.5.2 Service Volume ID (SVID)

The 4-bit SVID field shall identify the TIS-B site that delivered the surveillance data.

Note: In the case where TIS-B messages are being received from more than one TIS-B ground stations, the SVID can be used to select coarse messages from a single source. This will prevent the TIS-B track from wandering due to the different error biases associated with different sources.

A.2.4.5.3 Pressure Altitude

This 12-bit field shall provide the aircraft pressure altitude. This field shall contain barometric altitude encoded in 25 or 100-foot increments (as indicated by the Q Bit).

A.2.4.5.4 Latitude/Longitude

The latitude/longitude fields in the TIS-B coarse airborne position message shall be set as specified in A.1.4.2.3, except that the 12-bit form of CPR coding as specified in ***A.TBD*** shall be used.

A.2.5 TIS-B Management Messages

Note: TIS-B management messages announce the location and the service volume of the TIS-B ground station. This information aids in the selection of a ground site by an airborne TIS-B user. The management message is also used as a "keep alive" indication to alert a user when service becomes unavailable. .

A.2.5.1 TIS-B Management Message Content

TBD

Figure A-14: TIS-B Fine Airborne Position Message

1	
2	
3	FORMAT TYPE CODE
4	(See A.1.4.1 and Note 1)
5	
6	SURVEILLANCE STATUS
7	LSB
8	ATCRBS/Mode S Flag (AMS)
9	
10	
11	PRESSURE ALTITUDE
12	
13	
14	The altitude code (AC) as specified
15	in section 2.2.13.1.2 of DO-181B but
16	with the M-bit removed
17	
18	
19	
20	
21	Reserved
22	CPR FORMAT (F) (See A.1.4.2.1)
23	MSB
24	
25	
26	
27	
28	
29	
30	CPR ENCODED LATITUDE
31	
32	(CPR Airborne Format
33	See A.1.7.1 to A.1.7.5)
34	
35	
36	
37	
38	
39	LSB
40	MSB
41	
42	
43	
44	
45	
46	
47	CPR ENCODED LONGITUDE
48	
49	(CPR Airborne Format
50	See A.1.7.1 to A.1.7.4)
51	
52	
53	
54	
55	
56	LSB

Purpose: To provide airborne position information for aircraft that are not equipped with 1090 MHz ADS-B when the TIS-B service is based on high quality surveillance data.

Surveillance Status coding
0 = no condition information
1 = permanent alert (emergency condition)
2 = temporary alert (change in Mode A identity code other than emergency condition)
3 = SPI condition

Codes 1 and 2 take precedence over code 3.

Figure A-15: TIS-B Fine Surface Position Message

1	
2	
3	FORMAT TYPE CODE
4	(See A.1.4.1)
5	
6	
7	
8	
9	MOVEMENT
10	(See A.1.4.3.1)
11	
12	
13	STATUS for Gnd Tk (1 =valid, 0 = not valid)
14	MSB
15	
16	GROUND TRACK (7 bits)
17	(See A.1.4.3.2)
18	
19	**Resolution = 360/128 deg**
20	LSB
21	ATCRBS/Mode S Flag (AMS)
22	CPR FORMAT (F) (See A.1.4.2.1)
23	MSB
24	
25	
26	
27	
28	
29	
30	CPR ENCODED LATITUDE
31	
32	(CPR Surface Format
33	See A.1.7.1 to A.1.7.4 and A.1.7.6)
34	
35	
36	
37	
38	
39	LSB
40	MSB
41	
42	
43	
44	
45	
46	
47	CPR ENCODED LONGITUDE
48	
49	(CPR Surface Format
50	See A.1.7.1 to A.1.7.4)
51	
52	
53	
54	
55	
56	LSB

Purpose: To provide surface position information for aircraft which are not equipped with 1090 MHz ADS-B.

Figure A-16: TIS-B Identification and Category Message

1		
2		
3	FORMAT TYPE CODE (See A.1.4.1)	
4		
5		
6		
7	EMITTER CATEGORY	
8		
9	MSB	
10		
11	CHARACTER 1	
12		
13		
14	LSB	
15	MSB	
16		
17	CHARACTER 2	
18		
19		
20	LSB	
21	MSB	
22		
23	CHARACTER 3	
24		
25		
26	LSB	
27	MSB	
28		
29	CHARACTER 4	
30		
31		
32	LSB	
33	MSB	
34		
35	CHARACTER 5	
36		
37		
38	LSB	
39	MSB	
40		
41	CHARACTER 6	
42		
43		
44	LSB	
45	MSB	
46		
47	CHARACTER 7	
48		
49		
50	LSB	
51	MSB	
52		
53	CHARACTER 8	
54		
55		
56	LSB	

Purpose: To provide aircraft identification and category for aircraft that are not equipped with 1090 MHz ADS-B.

Type coding:

1 = Aircraft identification, category set D
2 = Aircraft identification, category set C
3 = Aircraft identification, category set B
4 = Aircraft identification, category set A

ADS-B Emitter Category coding:

Set A

0 = No ADS-B Emitter Category Information
1 = Light (< *15 500* lbs.)
2 = Small (*15 500* to 75 000 lbs.)
3 = Large (75 000 to 300 000 lbs.)
4 = High Vortex Large (aircraft such as B-757)
5 = Heavy (> 300 000 lbs.)
6 = High Performance (> 5 g acceleration and > 400kts)
7 = Rotorcraft

Set B

0 = No ADS-B Emitter Category Information
1 = Glider/sailplane
2 = Lighter-than-Air
3 = Parachutist/Skydiver
4 = Ultralight/hang-glider/paraglider
5 = Reserved
6 = Unmanned Aerial Vehicle
7 = Space/Trans-atmospheric Vehicle

Set C

0 = No ADS-B Emitter Category Information
1 = Surface Vehicle – Emergency Vehicle
2 = Surface Vehicle – Service Vehicle
3 = Fixed Ground or Tethered Obstruction
4-7 = Reserved

Set D : Reserved

Aircraft identification coding:

Coding as specified for A.1.4.4

Figure A-17: TIS-B Airborne Velocity Messages
(Subtypes 1 and 2: Velocity Over Ground)

BDS 0,9

1	MSB		**1**	
2			**0**	
3	FORMAT TYPE CODE = 19		**0**	
4			**1**	
5	LSB		**1**	
6	SUBTYPE 1	0	SUBTYPE 2	0
7		0		1
8		1		0
9	ATCRBS/Mode S Flag (AMS)			
10	Reserved			
11				
12				
13				
14	DIRECTION BIT for E-W velocity **(0=East, 1=West)**			
15	EAST-WEST VELOCITY (10 bits)			
16	NORMAL : LSB = 1 knot		SUPERSONIC : LSB =4 knots	
17	All zeros = no velocity info		All zeros = no velocity info	
18	Value	Velocity	Value	Velocity
19	1	0 kts	1	0 kt
20	2	1 kt	2	4 kt
21	3	2 kt	3	8 kt
22	-	-	-	-
23	1022	1021 kt	1022	4084 kt
24	1023	>1021.5 kt	1023	> 4086kt
25	DIRECTION BIT for N-S velocity **(0=North, 1=South)**			
26	NORTH-SOUTH VELOCITY (10 bits)			
27	NORMAL : LSB = 1 knot		SUPERSONIC : LSB =4 knots	
28	All zeros = no velocity info		All zeros = no velocity info	
29	Value	Velocity	Value	Velocity
30	1	0 kts	1	0 kt
31	2	1 kt	2	4 kt
32	3	2 kt	3	8 kt
33	-	-	-	-
34	1022	1021 kt	1022	4084 kt
35	1023	>1021.5 kt	1023	> 4086kt
36	Reserved			
37	SIGN BIT FOR VERTICAL RATE: 0 = up, 1 = down			
38	VERTICAL RATE (9 bits)			
39	All zeros – no vertical rate information, LSB = 64 ft/min			
40	Value		Vertical rate	
41	1		0 ft/min	
42	2		64 ft/min	
43	-		-	
44	510		32576 ft/min	
45	511		> 32608 ft/min	
46	Reserved			
47				
48				
49				
50				
51				
52				
53				
54				
55				
56				

Purpose: To provide velocity information for aircraft that are not equipped with 1090 MHz ADS-B when the TIS-B service is based on high quality surveillance data.

Subtype Coding

Code	Velocity	Type
1	Ground speed	normal
2		supersonic

Figure A-18: TIS-B Coarse Airborne Position Message

1	ATCRBS/Mode S Flag (AMS)	
2	**SURVEILLANCE STATUS**	
3		
4	MSB	
5	**SERVICE VOLUME ID (SVID)**	
6		
7	LSB	
8	MSB	
9		
10		
11		
12		
13	PRESSURE ALTITUDE	
14		
15		
16		
17		
18		
19	LSB	
20	**GRND TRACK STATUS** (1 = valid, 0 = invalid)	
21	**GROUND TRACK ANGLE**	MSB (180º)
22		(90º)
23		(45º)
24		(22.5º)
25		LSB (11.25º)
26	**GROUND SPEED**	MSB (1024 knots)
27		(512 knots)
28		(256 knots)
29		(128 knots)
30		(64 knots)
31		LSB (32 knots)
32	**CPR FORMAT (F)**	(0 = even, 1 = odd)
33		
34		
35		
36		
37		
38	CPR-ENCODED LATITUDE	
39		
40		
41		
42		
43		
44	LSB	
45	MSB	
46		
47		
48		
49		
50	CPR-ENCODED LONGITUDE	
51		
52		
53		
54		
55		
56	LSB	

Purpose: To provide airborne position information for aircraft that are not equipped with 1090 MHz ADS-B when the TIS-B service is based on moderate quality surveillance data.

Figure A-19: TIS-B Management

Purpose: To provide information about the location and the service volume boundaries of the TIS-B ground station

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